

In re Patent Application of:
KANE ET AL
Serial No. 10/662,086
Filed: 09/12/03

REMARKS

The Office Action is non-final. Claims 1 - 55 are pending. Claims 1 - 21 and 24 - 55 are rejected. Claims 22 - 23 are objected to. Claim 22 has been rewritten in independent form, as recommended by the examiner. Claim 24 has been amended to more clearly recite the source of pump radiation, while Claim 55 has been amended to correct a punctuation informality.

Applicants have reviewed the specification, as requested, and believe the text thereof, as originally filed, to be correct and accurate.

Claim 3 has been objected to, because it was written as depending from Claim 4. The dependency of Claim 3 has been corrected. Specifically, Claim 3 has been amended to depend on Claim 2, as inferred in the Office Action.

Reconsideration of this application in light of the above amendments and following remarks is respectfully requested.

The rejection of Claims 1-8, 10-12, 21, 25-26, 30-36, and 38-39, under 35 U.S.C. 103(a), as being unpatentable over the article by Spuhler et al. et al. (G. J. Spuhler et al., R. Paschotta, R. Fluck, B. Braun, M. Moser, G. Zhang, E. Gini and U. Keller), entitled: "*Experimentally confirmed design guidelines for passively Q-switched microchip lasers using semiconductor saturable absorbers*," Journal of the Optical Society of America B, Vol. 16, No. 4, March 1999), in view of Hargis et al. (US Patent 5,761,227), as set forth on pages 3-8 of the outstanding Office Action, is respectfully traversed.

The rejection initially alleges, with regard to Claims 1-3,

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that Spuhler et al. teach a laser apparatus comprising a Neodymium-doped lasing material (pg. 1 col.1-2 para.4-1, Nd:YVO₄) emitting pulsed radiation in the 1064nm wavelength range. It is then suggested, in the last sentence of the paragraph bridging pages 3 and 4 of the Office Action, that it would have been obvious to combine the teaching of Spuhler et al. with that of Hargis et al. The latter discloses a diode pumped Nd: YVO₄ micro laser (col.6 lines 25-27), in which the laser radiation wavelength of 914nm corresponds to an atomic transition from the ⁴F_{3/2} level to the ⁴I_{9/2} level of Neodymium in the lasing material.

In contrast to the conclusion reached in the Office Action, Applicants respectfully submit that there are several substantial aspects of Claims 1 to 3 of the present application, which cannot be inferred from a combination of the disclosures of Spuhler et al. and Hargis et al.

More particularly, the Neodymium concentration is crucial for achieving laser action and needs to be optimized for each host material, as well as each operating wavelength. For Nd:YVO₄ and operation at 1064nm, Spuhler et al. disclose 3% throughout (for instance, Figs. 8, 9, 10, 13; also page 384 para 3; Table 1 lines 2 and 5). In a different host material, Nd:YAG, operating at 1064nm, Spuhler et al. disclose ~1.1%. However, this design indicates an absorption length of 1200 microns, which is too long to achieve the short pulse lengths, which are attained by the invention claimed in the present application. Presumably, for this reason, the Nd:YAG design does not appear in Table 2 of Spuhler et al.

It is important to note that a thorough reading of the article by Spuhler et al. reveals no teaching or suggestion of any trend or correlation of doping level with wavelength or material, from which one skilled in the art could deduce the

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appropriate doping level for 914nm operation.

The patent to Hargis et al. has been cited as teaching lasing at 914nm. In Col. 12, lines 1-3, Hargis et al. state:

"Particularly preferred with Nd:YVO₄, is a length (along the optical axis) of about 0.3 mm and a concentration of about 1.0 at. %."

Hargis et al. further describe that the dopant concentration - crystal length product - should lie within certain limits (Col. 11, lines 65-67):

"For Nd: YVO₄, the dopant concentration-crystal length product is within the range of 0.1 at. %-mm to 0.5 at. %-mm. depending upon the specific pump and cavity configurations."

The dopant concentration-crystal length product for Hargis et al.'s preferred design is 0.30 at. %-mm.

On page 21, line 17 of the present application, Applicants indicate that they "obtained their best results at a thickness of about 0.075 mm." Regarding a preferred dopant level, Applicants have described on page 21, line 3, that "a Nd concentration of about 2% works particularly well."

From this description, the dopant concentration-crystal length product can be readily calculated as being 0.15 at. %-mm, which is one-half of the value disclosed by Hargis et al. In fact, if one were to apply Hargis et al.'s preferred dopant concentration-crystal length product of 0.30 at. %-mm to the crystal length of 0.075mm described in the present application, one would arrive at a dopant concentration of 4.0%, which is

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twice the limit of the range between 0.2 and 2.0% disclosed at Col. 11, lines 54-57 of Hargis et al.

Applying the same criterion to the parameters disclosed by Spuhler et al., the derived values lie in a range from 0.55 at. %mm to 0.60 at. %mm, which is outside the range given by Hargis et al. (0.1 at. %mm to 0.5 at. %mm). This constitutes a further inconsistency between Spuhler et al. and Hargis et al., that prevents the values disclosed and claimed in the present application from being "obvious" to one skilled in the art in light of the cited prior art documents to Spuhler et al. and Hargis et al.

As Applicants have stated in lines 9-11, on page 14, of the present specification, "the values that were arrived at are not calculable from any theory, and were determined by an expensive and time-consuming process of multi-parameter testing".

As pointed out above, these values are neither disclosed nor suggested Hargis et al. or Spuhler et al. Moreover, the values disclosed and claimed herein could not have been realized by routine experimentation, since the large number of parameters (10, from page 20, Table 1 of the specification) involved in the optimization yields a factorially larger number of combinations required for experimental purposes, that is greater than what one skilled in the art would consider routine.

It should also be noted that Hargis et al. do not consider pulsed mode of operation of their laser system; the patentees are silent on all aspects related to the generation of short pulses, including the application of passive Q-switching mechanisms. Notably, one of the key parameters is cavity length, to which the crystal length contributes substantially. The preferred crystal length of about 0.3 mm disclosed by Hargis et al. (Col. 12, lines

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1-3) is four times larger than that disclosed by Applicants for short pulse operation. This factor of four is very large, which clearly demonstrates that Hargis et al. teach away from the Applicants' optimized value for short pulse operation. Therefore, it is not readily apparent that the preferred length of about 0.3 mm disclosed by Hargis et al. would be capable of generating pulses sufficiently short for the applications disclosed and claimed by Applicants, namely, pulses of a duration of 1.5ns or shorter.

With respect to Claim 4, although Spuhler et al. provide an example of Nd concentration around 1.1% for Nd:YAG operating at 1064nm (Table 1), this design also indicates an absorption length of 1200 microns, which would preclude pulsed operation below pulse lengths of 1.5 ns.

A careful reading of the Spuhler et al. article reveals that nowhere do the authors indicate a range of dopant concentrations for any specific material, including Nd:YVO₄; only a single value of 3% is used throughout the article. This value is 50% higher than the preferred dopant concentration disclosed by Applicants. The single values Spuhler et al. disclose for each of the above materials (Nd:YAG, Nd:YVO₄) do not represent a range, let alone the range (1% - 3%) claimed by Applicants for the lasing material Nd:YVO₄.

With regard to Claim 5, Hargis et al. disclose an optimum dopant concentration of 1% (Col. 12, lines 1-3), which is one-half of the optimum value disclosed and claimed by Applicants. This constitutes a substantial difference from the claimed value of 2%, especially when considering the dopant concentration - crystal length product, as explained above.

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With respect to Claim 6, Spuhler et al. disclose that the lasing material is about 100 microns thick (page 386, para. 1), but is strictly in the context of operation at 1064nm. The experimental data presented in the article is about twice to four times the thickness (Table 2). Spuhler et al. specifically refers to their best results (Fig. 1, referred to on page 386, para. 1) as being obtained with a length of 187 microns. Namely, Spuhler et al. disclose no results for a length of 100 microns.

In addition, at a dopant concentration of 3%, Spuhler et al.'s disclosure regarding the dopant concentration - crystal length product differs from that disclosed by Hargis et al.

In contrast thereto, Applicants' Claim 6 recites a continuous range of crystal lengths, from 50 microns to 100 microns.

With respect to Claims 7 and 8, Spuhler et al. describe an operating wavelength of 1064nm, whereas Applicants' laser system operates at a different wavelength (914nm). As explained above, the substantial differences that exist between the two systems precludes the automatic assumption that reflectivity values useable at one wavelength are also useable at another wavelength.

With respect to Claim 10, Spuhler et al. and Hargis et al. fail to disclose or suggest the laser apparatus discussed above, with reference to the rejection of Claim 1. The fact that Spuhler et al. further disclose, in their Figure 6, a Q-switch including a saturable Bragg reflector (SBR) does not remedy the shortcoming of the rejection, so that Claim 10 is believed to be patentable for the reasons that Claim 1 is patentable.

As to the perfecting features of the invention recited in

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Claims 11, 12 and 21, which depend upon Claim 1, Applicants respectfully submit that these claims, like Claim 10, are patentable over Spuhler et al. and Hargis et al., for the same reasons that Claim 1 is believed to be patentable thereover, as discussed above.

Independent Claim 25, as well as Claims 26, 30-36, 38 and 39, dependent thereon, are believed to be patentable over Spuhler et al. and Hargis et al. for the reasons discussed above regarding the patentability of Claims 1-8, 10-12 and 21. Claim 25 essentially recites the combination of the laser components of Claim 1, plus a source of pump radiation. As Spuhler et al. and Hargis et al. fail to disclose or suggest the combination of Claim 1, they fail to disclose or suggest that combination plus the source of pump radiation of Claim 25.

The rejection of Claims 9 and 37 under 35 U.S.C. 103, as being unpatentable over Spuhler et al. and Hargis et al., discussed above, as supplemented by the U.S. patent to Yin ('578), for the reasons set forth on page 8 of the outstanding Office Action, is respectfully traversed. The patent to Yin has been cited for its disclosure of a coating for a lasing material for particular transmission/reflection percentages associated with ordinary (O) and extraordinary (E) polarizations. The values of the parameters claimed in Claims 9 and 37, which respectively depend upon Claims 1 and 25, discussed above, are not taught or suggested by the different values of Yin; moreover, Yin does not address the combination of features of independent Claims 1 and 25. Consequently, Claims 9 and 37 are believed to be patentable.

The rejection of Claims 13-16, under 35 U.S.C. 103, as being unpatentable over Spuhler et al. and Hargis et al., discussed above, as supplemented by the U.S. patent to Weingarten et al.

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('219), for the reasons discussed on pages 8 and 9 of the outstanding Office Action, is respectfully traversed. The secondary patent to Weingarten et al. ('219) has been cited to show the use of reflecting layers to reflect at greater than 99.5% and having a thickness of a quarter wavelenth. Whether or not such is the case, Weingarten et al. ('219) do not remedy the above-discussed deficiencies of Spuhler et al. and Hargis et al. with respect to Claim 1, upon which Claims 13-16 ultimately depend. Consequently, Claims 13-16 are believed to be patentable.

The rejections of Claims 17-20, under 35 U.S.C. 103, as being unpatentable over Spuhler et al. and Hargis et al., discussed above, as supplemental by either or both of the U.S. patents to Paschotta et al. ('234) and Weingarten et al ('219), for the reasons set forth on pages 10 and 11 of the outstanding Office Action, are respectfully traversed. The patent to Paschotta et al. has been cited to show the use of InGAs and GaAsP layers. Weingarten et al. has been cited to show an odd multiple of a quarter wavelength layer thickness. Whether or not such is the case, neither supplemental reference discloses or suggests the deficiencies of the primary references to Spuhler et al. and Hargis et al. with respect to Claim 1, upon which Claims 17-20 ultimately depend. As a consequence Claims 17-20 are believed to be patentable.

The rejection of Claim 24 is respectfully traversed for the same reasons that the rejection of Claim 1, upon which Claim 24 ultimately depends, is traversed, as discussed above. The supplemental U.S. patent to Weingarten et al. ('035), which has been cited to show a diode providing more than 400 watts/mm² of output power, does not supply the shortcomings of the article by Spuhler et al. and the patent to Hargis et al. with respect to Claim 1, upon which Claim 24 depends. Consequently, Claim 24 is

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believed to be patentable.

The rejection of Claims 27 and 29, under 35 U.S.C. 103, as being unpatentable over Spuhler et al. and Hargis et al., discussed above, as supplemented by the U.S. patent application publication to Spuhler et al. ('060), for the reasons discussed on pages 12 and 13 of the outstanding Office Action, is respectfully traversed. As discussed above, the inadequacies of the article by Spuhler et al. and the patent to Hargis et al. with respect to Claims 1, apply equally to Claim 25, upon which Claims 27 and 29 ultimately depend. The patent application publication to Spuhler et al. ('060) has been cited for a particular lens arrangement (lens 11, 13 and 14 in Figure 1) and a beamsplitter (21 in Figure 1). However, such components do not remedy the inadequacies of the article by Spuhler et al. and the patent to Hargis et al. to the combination of features of Claim 25, upon which Claims 27 and 29 depend. Consequently, for the reasons discussed above with respect to Claims 1 and 25, Claims 27 and 29 are believed to be patentable.

Similarly, Claim 28 is believed to be patentable for the same reasons that Claim 25, upon which Claim 28 ultimately depends, is considered patentable. As discussed above, the supplemental references to Weingarten et al. ('035) and Spuhler et al. ('060) do not disclose or suggest the features of Claims 1 and 25 absent from the article to Spuhler et al. and the patent to Hargis et al.

The rejection of Claims 40-47 and 49-51, for the reasons set forth on pages 14-16 of the outstanding Office Action, relying on the article by Spuhler et al., the patent to Hargis et al., and the U.S. patent application publication to Kubota et al. ('246), is respectfully traversed.

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Independent Claim 40, upon which Claims 41-47 and 49-51 depend, recites a combination of components of which a PQSL is configured. This combination includes the components of Claims 1 and 25, as well as a neodymium-doped cladding-pumped fiber amplifier and an optical harmonic generator, to which the PQSL is coupled. Since the cited references to Spuhler et al. and Hargis et al. do not disclose or suggest the features of Claims 1 and 25, as discussed above, they do not render unpatentable a combination of such features and the additional structure of Claim 40.

The publication to Kubota et al. ('246) has been cited to show a cladding-pumped Nd-doped fiber amplifier and an optical harmonic generator. Such components, however, do not overcome the inadequacies of Spuhler et al. and Hargis et al. to the other features of Claim 40, that are common to Claims 1 and 25. As a consequence, it is respectfully submitted that Claims 40-47 and 49-51 are not rendered unpatentable by the addition of the reference to Kubota et al. ('246) to supplement the references to Spuhler et al. and Hargis et al.

The rejections of Claims 48 and 52-54, under 35 U.S.C. 103, relying upon the cited references to Spuhler et al., Hargis et al., Kubota et al. ('246), Yin ('578), Spuhler et al. ('060), and Weingarten ('035), for the reasons set forth on pages 16-18 of the outstanding Office Action, are respectfully traversed for the same reasons discussed above in connection with the traversal of the rejection of Claim 40, upon which Claims 48 and 52-54 depend.

As urged above, the secondary references, cited to supplement the article to Spuhler et al. and the patent to Hargis et al., do not remedy the shortcomings of the primary references with respect to the common combination of features shared by each of independent Claims 1, 25 and 40. Consequently, they do not disclose or suggest the totalities of features of the claims

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dependent thereon, including Claims 48 and 52-54, which depend upon Claim 40. Thus, Claims 48 and 52-54 are believed to be patentable.

The rejection of Claim 55, under the provisions of 35 U.S.C. 103, relying on the cited primary references to Spuhler et al. and Hargis et al., as supplemented by the secondary references to Kubota et al. ('246) and the U.S. patent to Moulton ('190), for the reasons discussed on page 19 of the outstanding Office Action, is respectfully traversed.

Claim 55 recites a combination of components of which a display system is comprised. This combination includes those that make up the blue light-producing apparatus of Claim 40, as well as a multicolor light source, a modulating means and a scanning means. As discussed above, the combination of features recited in Claim 40 is not taught or suggested by the references to Spuhler et al., Hargis et al. and Kubota et al. ('246), so that such prior art is equally inapplicable to Claim 55.

The supplemental patent to Moulton ('190) has been cited to show a display system having a multicolor light source, modulating means and scanning means. However, it contains no teaching or suggestion of modifying, or how to implement a modification of, the laser apparatus of Spuhler et al. to realize a display system upon which Claim 55 would read. Claim 55 is therefore considered to be patentable for the same reasons that Claims 1, 25 and 40 are believed to be patentable.

With respect to objected to Claims 22 and 23, Claim 22 has been rewritten in self-contained form to include the limitations of independent Claim 1 and intervening Claims 10, 11 and 21. Original Claim 23 remains dependent on (now independent) Claim 22. As such, it is Applicant's understanding that Claims 22 and

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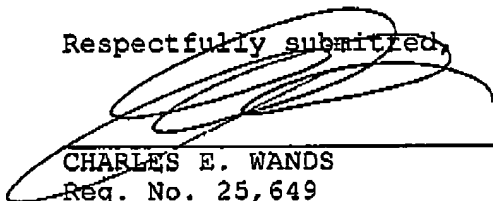
23 are now in condition for allowance.

However, in view of the foregoing demonstration of the failure of the cited prior art to disclose or suggest the various combinations of features of the invention claimed in the rejected claims, favorable reconsideration of this application, and a Notice of Allowability of all of Claims 1-55 are respectfully requested.

Should any minor informalities need to be addressed, the Examiner is respectfully requested to contact the undersigned attorney at the telephone number listed below.

Please charge any shortage in fees due in connection with the filing of this paper, including Extension of Time fees, to Deposit Account No. 50-1465 and please credit any excess fees to such deposit account.

Respectfully submitted,



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CERTIFICATE OF FACSIMILE TRANSMISSION

I HEREBY CERTIFY that the foregoing correspondence has been forwarded via facsimile number 571-273-8300 to MAIL STOP AMENDMENT, COMMISSIONER FOR PATENTS, this 30 day of November 2005.



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